REMARKS/ARGUMENTS

1. Rejections of claims 1-4, 6, 8, 9, and 20 under 35 U.S.C. 102(e):

Claims 1-4, 6, 8, 9, and 20 are rejected under 35 U.S.C. 102(e) as being anticipated by US 6,271,553 B1 (Pan '553) considered with the basic textbook, Ghandi, VLSI Fabrication Principles, 2nd ed., John Wiley & Sons: New York, 1994, p. 393 for a showing of inherency for claim 8 only. Reasons of record are recited on pages 2-5 of the above-indicated Office action.

Response:

Claim 1 is amended for clearly defining the method of forming a photo sensor. The amended claim 1 is listed below with a clear version for explaining the difference between the present application and Pan '553.

Claim 1: A method of forming a photo sensor in a photo diode formed on a semiconductor wafer, a surface of the semiconductor wafer comprising a substrate with first-type dopants, and an insulating layer positioned on the surface of the substrate and surrounding the photo sensor, the method comprising:

forming a first mask layer on the surface of the substrate for defining positions of a plurality of first doped regions *distributed in the photo sensor*;

performing a first ion implantation process utilizing second-type dopants to *form the plurality of first doped regions for increasing a contacting area between each first doped region and the substrate so as to increase a sensing area of the photo sensor*;

removing the first mask layer and forming a second mask layer surrounding the photo sensor; and

performing a second ion implantation process utilizing second-type dopants to form a second doped region on the surface of the photo sensor, and *the second doped region*

covering a top surface of each of the first doped regions and the surface of the substrate between any two adjacent first doped regions.

According to the amended claim 1 and Figs.4-5 of the present application, the present application includes the following characteristics: (1) *The plurality of first doped regions are distributed in the photo sensor and that increases the contacting area between each first doped region and the substrate so as to increase the sensing area of the photo sensor.* (2) *The second doped region 46 is formed on the top surfaces of the first doped regions 42 and on the top surface of the substrate (the P-type epitaxial silicon layer 34) between any two adjacent first doped regions 42.* Accordingly, the second doped region 46 and the P-type epitaxial silicon layer 34 form a *shallower depletion region for effectively improving the sensitivity of the photo diode to light with short wavelengths* (such as blue light)(para [0021], lines 6-9). (3) The first doped regions 42 having a larger depth are formed previously before forming the second doped region 44.

Regarding Pan '553, he discloses a method for fabricating a photo sensor in a photo diode, including performing two ion implantation processes *to form a first doped region 42 and a second doped region 44 in order* (Figs.2 and 7, col. 4, lines 31-41). It should be noted that *the second doped region 44 has a greater depth than the first doped region 42, and only one first doped region 42 and only one second doped region 44 are formed in the photo sensor 40 and around the photo sensor respectively* (col. 4, lines 32, 37). Since only one second doped region 44 having larger depth is formed surrounding the photo sensor 40 and *only in the periphery portion of photo sensor* for reducing the electrical field under the field oxide layer 38 around the first doped region 42 to reduce the noise associated with this field, *the device of Pan '553 cannot provide an increased sensing area of the photo sensor.* (col. 3, lines 23-25, 30-33, and col.4, line 65 to col. 5 line 1). Therefore, the fabrication method is obviously different from claim 1 of the present application.

In addition, the first doped region 42 having a smaller depth is surrounded by the second doped region 44 and is not positioned on the second doped region 44. *Therefore, Pan never teaches forming a plurality of first doped regions 42 or second doped regions 44 distributed in the photo sensor 40 and forming a first or second doped regions 42,44 on the top surfaces of the other doped region.* Accordingly, the applicant contends that this application is quite different from the Pan's application and the amended claim 1 should be allowable. Reconsideration of claims 1 is hereby politely requested.

Regarding claim 20, the present application forms *a plurality of depletion regions* 48 (Fig.5, para. [0021]-[0022]). However, Pan '553 only discloses forming one depletion region 46 in Fig.2. Therefore, applicant believes claim 20 should be allowable.

Since claims 2-4, 6, 8, 9, and 20 are dependent upon claim 1, they should be allowed if the amended claim 1 is allowable. Reconsideration of claims 2-4, 6, 8, 9, and 20 is therefore requested.

2. Rejections of claims 1, 2, 4, 5, 7, 8-10, 20, and 21 under 35 U.S.C. 102(b):

Claims 1, 2, 4, 5, 7, 8-10, 20, and 21 are rejected under 35 U.S.C. 102(b) as being anticipated by US 6,150,189 (Pan '189) considered with the basic text book, Ghandi, VLSI Fabrication Principles, 2nd ed., John Wiley & Sons: New York, 1994, p.393 for a showing of inherency for claim 8 only. Reasons of record are recited on pages 5-8 of the above-indicated Office action.

Response:

Pan '189 discloses a method for fabricating a photo sensor in a photo diode, including performing two ion implementation processes to form a first doped region 28 and a second doped region (Figs. 5-6). According to col. 3, lines 43-44, *each of the*

second doped regions 42, the shallower doped regions, is surrounded by one of the first doped regions 28 for serving as a conductive line connecting to the photo sensor area, and *never covers the top surface of the substrate 22 between adjacent first doped regions 28.*

In contrast to Pan '189, the amended claims 1 and 21 of the present application define that the second doped region *covers the top surface of each first doped region and the surface of the substrate between any two adjacent first doped regions.* Accordingly, it is *the second doped region that surrounds the plurality of first doped regions* in the photo sensor. Since Pan'189 never teaches forming the second doped region that covers the substrate between adjacent first doped regions and nor teaches forming one second doped region surrounding the first doped regions, the applicant believes the amended claims 1 and 21 of the present application are quite different from Pan '189 and never disclosed by Pan. Therefore, reconsideration of the amended claims 1 and 21 is respectfully requested.

Claims 2, 4, 5, 7, 8-10, and 20 are dependent upon claim 1. They should be allowed if the amended claim 1 is allowable. Reconsideration of claims 2, 4, 5, 7, 8-10, and 20 is hereby requested.

3.Rejection of claims 7 and 21 under 35 U.S.C. 103(a):

Claims 7 and 21 are rejected under 35 U.S.C. 103(a) as being obvious over Pan '553. Reasons of record are recited in pages 8-9 of the above-indicated Office action.

Response:

Claim 7 is dependent upon claim 1. Therefore, claim 7 should be allowable if the amended claim 1 is allowable. Reconsideration of claim 7 politely requested.

As discussed in parts 1 and 2 of the REMARKS/ARGUMENTS section, claim 21 defines performing a second ion implementation process to form a second doped region

covering the top surface of each first doped region and the surface of the substrate between any two adjacent first doped regions. However, Pan 553' never suggest to form a second doped region covering the substrate between two adjacent first doped regions. Therefore, compared with Pan '553, the amended claim 21 should be patentable. Reconsideration of the amended claim 21 is hereby requested respectfully.

4. Rejections of claims 1-5 and 8-10 under 35 U.S.C. 103(a):

Claims 1-5 and 8-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 5,767,538 (Mullins et al.) in view of Van Zant, Microchip Fabrication, 4th ed. McGraw-Hill: New York, 2000, pp. 72-74, for reasons of record that can be found in pages 9-11 of the above-identified Office Action.

Response:

As discussed above, the first doped region of the present application is distributed in the photo sensor so as to increase the contacting area of the first doped region and the P-type epitaxial silicon layer of the substrate for effectively increasing the sensing area of the photo sensor.

Mullins disclose a photodiode device, which includes a frame-shape P+ contact diffusion 47 having a larger depth and a shallower P+ ion-implanted region 46 on the surface of the substrate and the top surface of the P+ contact diffusion 47. P+ ion-implanted region 46 forms a photo junction 46A with the underlying N- epitaxial region 51, such that light 6 impinging on this structure produces a first photocurrent in photo junction 46 A. Since the P+ contact diffusion 47 is used for providing convenient coupling of the P+ anode of photodiode 5 to the ground or the (+) input of transimpedance amplifier 2 (col.9, lines 1-10, Figs.3A-3B), *the frame-shape P+ contact diffusion 47 only surrounds the photodiode 5 but not distributed in the photodiode 5.* Therefore, the *P+ contact diffusion 47 cannot increase the sensing area. Furthermore,*

Van Zant never mentions forming a plurality of first doped regions distributed in the photo sensor to increase the sensing area. Accordingly, applicant believes the amended claim 1 should be allowable. Reconsideration of the amended claim 1 is therefore requested.

Claims 2-5 and 8-10 are dependent upon claim 1. Therefore, they should be allowable if the amended claim 1 is allowable. Reconsideration of claims 2-5 and 8-10 is politely requested.

5. New claim introduction:

Claim 22 is introduced in this amendment to further define that the step of performing a first ion implantation process forms at least three of the first doped regions 42 distributed in the photo sensor for increasing the sensing area (Figs.3-5). Applicant contends none of the above-mentioned prior arts disclose forming three or more first doped regions distributed in the photo sensor and therefore the new claim 22 should be allowable. Consideration of the new claim 22 is respectfully requested.

Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Sincerely yours,

Winston Hsu Date: August 16, 2005

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Note: Please leave a message in my voice mail if you need to talk to me. (The time in D.C. is 12 hours behind the Taiwan time, i.e. 9 AM in D.C. = 9 PM in Taiwan.)